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AUTOMATION IN MACHINE DESIGN CALCULATIONS VIEWED

Prague STROJIRENSTVI in Czech No 1, 1982 pp 2, 3

[Article by Doc Eng J. Dvorak, DSc, State Research Institute for Machinery Construction, Prague: "Automation of Computer Operations in Design of Machinery Systems"]

[Text] The progress of introduction of computers into common use and development of programs over the past 15 years has been more or less unrestrained, as there were no provisions for organized procurement of computers of a uniform series. The situation deteriorated so far that, e.g., in one case institutions collaborating on a joint project were using 16 different types of computers with 11 different languages. Programs with a similar orientation were naturally developed simultaneously in more places, because conversion from one computer to a different type of computer is, as a rule, more cumbersome than compilation of a new program.

Of course, duplicity in development of programs is unwanted, as it represents an uneconomical expenditure of human effort and funds. For that reason, by the end of the sixties the search was on for ways of precluding the situation. Several moves were undertaken with the intent of compiling a list of available programs with a general orientation. It was envisioned that the list would facilitate their exchange between institutions, or conduct of computations on demand. It turned out, however, that due to the diversity of computers it was usually impossible to transfer programs and there were usually no facilities for performing computations for other organizations.

With the introduction of the uniform series of computers JSEP [Uniform System of Electronic Computers] the situation is undergoing a change. If they will form the equipment of most enterprises, then with uniformity of programming languages, compilers and assemblers, operational systems, etc., the practical significance of such a record of programs will increase.

The State Research Institute for Machinery Construction was assigned the task of developing a comprehensive library of programs, as a set of uniformly arranged information in regard to programs, which would be generally available to any interested party. The institute devised a concept of the library, thought out the structure for acquisition of data about programs, the manner of recording the data by means of record lists and organization of data collection.

Recording of programs is conceived on an international scale. It is the subject of scientific and technical cooperation among CEMA countries, with the CSSR being the main coordinator for this topic. The future will show of what benefit this action will be.

The now generally used method of finite elements is prevalent among solution-oriented methods. It has proved its all-purpose application and effectiveness in dealing with tasks of the more varied phsyical nature that often could not be solved before. In addition to classical applications in problems of linear theory of elasticity, in dynamics of structures and in heat conductance, now is is also used in unconventional applications, such as in determination of the configuration of a tool in electrochemical machining, computation of the diffusion of alloying elements in steel grains, in the area of heat and mass transfer, in the sphere of flux and convection, propagation of shock waves, fracture mechanics, etc.

Another advantage offered by this method is its early algorithmization. Algorithms for the solution of varying problems are often resemblant in many respects and most of them call for identical elemental operations, such as, e.g., data input for description of elemental networks, description of the physical properties of the problem, composition of matrices of elements, operation with matrices, solution of systems of equations, etc. It virtually offers of itself the possibility for compilation of programs for solution of multiple tasks and that is why even at the outset of development of applications, more or less all-purpose programs for solution of certain classes of problems were compiled in most places. The compilation gradually progressed to more general-purpose and complex programs and the early seventies already saw operation of large complexes of programs, some of which were worked out into a large scope with a capacity for more than 300,000 instructions and found application in industrial and research work all over the world. Some even became a part of computer software.

A large amount of experience, mostly positive, was made over the past approximately 10 years in utilization of large general-purpose systems. However, there were also some objections, particularly against the systems being closed. In spite of the general orientation of most of them, there often cropped up problems which they could not handle at all, or only at the expense of an excessive simplification of the problem, or at the expense of economy. After all, no system has a fully all-purpose application and each bears the effects of its originator's orientation. As adaptations and supplementing of systems are difficult, for workplaces dealing with various problems arose the need to replace the closed system by a system of blocks that could be used in compilation of programs for the solution of problems of a different nature according to immediate needs. This led to an improved approach to providing programs for scientific and technical computations, i.e., the concept of packets--"packages." This term denotes a system of mutually compatible segments which can be used to compile simple and economic programs optimally suited for the given problem and the computer used.

As a result, the State Research Institute for Machinery Construction started in 1976 to work out a programming system for calculations used in the design

of machinery designated by the abbreviation PMD (Package for Machine Design). The PMD system will always be open both as to the type of the given problems and the methods used, which constitutes its basic property. Like every programming library, the PMD can accommodate new units. Its first version from 1978 includes primarily subprograms for standard operations in all algorithms, means for solution of two- and three-dimensional problems of a stationary and nonstationary scalar field and elastostatics and subprograms for computation of service life in low-cycle fatigue.

As it is impossible in a single workplace to allocate for work on the system a number of personnel that would warrant its expansion to the desired scope in an acceptable period of time, it must be made accessible also to external personnel. For that reason, the system is available to all interested parties and is arranged so as to make its expansion as simple as possible. Uniform rules were introduced for building up the system, the programs are arranged so as to facilitate orientation and understanding, and the programming is simple.

Special attention was devoted to the arrangement of input data and the manner of using them, as their acquisition and verification of their correctness is one of the most time-consuming steps. An important group of input data is the description of the form of the domain, description of the network of elements, their numbering, numbering of junction points and readout of their coordinates.

Generation of networks for two-dimensional problems has already been mastered and there are programs for their automated generation. In the solution of spatial problems, the form can be rendered discrete in a number of ways. The most primitive, most laborious--and, as such, most susceptible to introduction of errors into the calculations--is manual generation of the network from a graphic representation in axonometry, or in rectangular projections. If permitted by the nature of the configuration of a part, it is possible to make use of the so-called substructures, i.e., generate for recurring structural parts of identical configuration a common matrix of rigidity, the order of which can be futher decreased by so-called condensation, and solution of the resultant system can also be accelerated. An analogous approach could be used for large machinery components (forgings or thick-walled castings) where the inner part would be filled out by the so-called macroelements. The method of binomial integral equations could be used in computation of their matrices.

Another source for acquisition of input topological data are the so-called special or object-oriented generators. They can be used with advantage in development of type series of machinery components of similar shape, or of entire machinery assemblies (runners of hydraulic and gas turbines, pumps, parts of high-pressure fittings, parts of combustion engines, electric motors, etc). Herein the network of one member of the type series is processed manually. Its correctness is verified by plotting, e.g., with the aid of Didigraf, and the numbering of elements or points of juncture is optimized. These data are fed into a special program--a network generator which, after being provided with several basic dimensions of another member of the series, then transforms the network. It is envisioned that cooriginators of PMD will be also working on these object-oriented generators.

Another important approach to attainment of the goal of designing by means of computer would be reversal of this process. After input of the required or admissible values--e.g., limits of fatigue, admissible deformation, tension, temperature gradient, etc.--for given points of the part, the basic dimensions of the member of the type series would be obtained as output information. It involves a very demanding process whose development is just getting under way. Some collaborating organizations also work on programs for graphical processing of calculation results, which is an essential part of designing by means of a computer.

Input data describing the configuration of the given body are fed and processed always separately and ahead of all others. They are processed by independent programs, preprocessors, which read the data, check, print and sort it for processing in a uniform way and the processing results are stored in an external memory where they are available for all problems dealt with for a given body.

Data describing physical properties, material properties, load, boundary conditions, etc., are organized along similar lines. They are read at the start of each program for processing of the problem, always by the same subprogram, independently of the physical character of the problem.

Quality control of input data of all kinds considerably affects the practical application of a program. For that reason the PMD tests the admissibility of all data for input, correctness and completeness of description for adding a set of values, as well as their mutual relations. A report is printed out about each detected error, specifying the type of error and, if possible, location of the erroneous entry on the card. Once an error has been detected, input into the disk is interrupted, but reading of input data continues so that all input data can be checked. Reading of data is followed by the actual processing of the problem. A particularly significant operation, from the viewpoint of use of computer time, is solving of a system of equations for unknowns of junction points. In view of the fact that the library of elements PMD contains only isoparametric elements and related elements, it was decided to accomplish solution of equations by the frontal method designed specifically for problems being solved by means of these elements.

After proposing the structural arrangement and the function of the system it became necessary to specify uniform rules for programming itself. Uniform, a priori adopted and systematically adhered to rules for programming are the unifying factors which differentiate PMD from the heterogeneous set of subprograms, even though they do serve a specific purpose. After some unfortunate experience with orientation of programs for a certain type of computer and the peculiarities of its software, it was decided to adapt programming in PMD so that the system could be used with most computers of requisite capacity installed in the CSSR. Specifically, these are computers of the uniform series JSEP starting with type 1033, IBM computers of the 360 and 370 series, computers ICL series 1900, computer ODRA 1305 and BESM 6. Standard FORTRAN IV was selected as the programming language. This selection was affected primarily by the requirement to make the system accessible to the largest possible number of programmers. Even though it is considered to

be an obsolescent language, it is still most widely used, most programmers are familiar with it and all computers that were under consideration do have effective compilers for its translation.

The first version of the directives for PMD programming from 1978 was supplemented after 3 years by findings made in an experiment with so-called structured programming. Thus originated the current rules for internal standardization of PMD programming which will form the basis for the first revision (updating) planned for 1982.

PMD is one of the important links in automation of design operations, sometimes referred to elsewhere in the world by the term CAD (Computer Aided Design). Devising of a system for automation of design operations, abbreviated as SAPR (Sistyema Avtomatizatciyi Proyektnykh Rabot [System for Automation of Design Operations]) is the subject of collaboration among socialist countries and is coordinated by the Council of the Intergovernmental Commission for Utilization of Computer Technology. Programs derived from the system found practical application and more parties are becoming interested in them. The interested parties include not only those who routinely want to use finished programs, but also those interested in creative collaboration in expansion of the system. By the end of 1981, PMD was used and expanded upon at a total of 12 workplaces. In 1982, the group of plants producing machinery, institutions of higher education, institutes of academies of sciences and other research institutes from the CSSR, USSR and GDR is expected to exceed 30.

This is a start in the implementation of the original intent which was to make the system a joint product of all its users. That provides a guarantee that it will be possible to expand the system in a foreseeable time to the point that it will be of use to the entire sector of machinery construction.

The technological public will be familiarized with the description of individual segments of PMD, the rules for standardization and the manner of their application, to include examples, in a series of articles to be published in this periodical.

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HUMAN BIOLOGY PROBLEMS IN POLAR RESEARCH DESCRIBED

Warsaw POSTEPY ASTRONAUTYKI in English No 3, Mar 81 pp 35-47

[Article by Krzysztof Kwarecki, Jan Terelak, Military Institute of Aviation Medicine, Warsaw: "Problems of Human Biology in Polish Polar Research"]

[Text]

The biomedical aspect of the scientific programme of polish polar research consists of the following problems: determination of course of the selected physiological functions of human beings in relation to a place and a duration of staying in the polar conditions; research on the basic human biorhythms in the polar conditions; characterization of the psychosocial phenomena in human beings during isolation in the polar conditions; elaboration of health standards and the criteria for recruitment of the cadidates, and of the rules of a prophylactic action and a medical treatment.

Selected physiological functions of human beings in the polar conditions

The investigations are performed among the members of the winter crew of the Arctowski memorial Polish Antarctic Station (PAS), situated on King's George Island. A climate in this area is characteristic for the Antarctic Continent shores; it is less severe than one in stations situated deep into a continent. Some parameters of a climate in the area of PAS are given in table 1.

The severity of the climate is determined by strong and frequent winds which potentiate the effects of low temperatures. In table 2 the indices of climate severity during summer and winter seasons are given.

Table 1. Some parameters of climate (10-years observations); King George Island - Admiralty Bay (after British Station, Martel Inlet)

Month	p(mbar)	Air temperature (°C)		Maximal temperature	Minimal temperature
		maximal	minimal		
January	990	3	-1	10	-5
August	993	-4	-11	6	-32
Year	991	0	-5	11	-32

Table 2. Wind chill index (after siple and passel)

Air temperature (°C)	Wind velocity (m/s)			
	5	10	15	20
+ 10.0	569	803	981	1131
+ 5.0	691	973	1190	1373
0.0	813	1146	1402	1618
- 5.0	935	1319	1613	1861
- 10.0	1057	1491	1824	2105
- 15.0	1180	1664	2035	2349
- 20.0	1301	1836	2246	2593
- 25.0	1423	2008	2458	2836
- 30.0	1544	2180	2669	3080
- 35.0	1666	2353	2880	3324
- 40.0	1788	2525	3091	3567

Broken line - summer, solid line - winter

The apartments in PAS have an electric heating which guarantee the appropriate temperature of the rooms. A temperature could be changed in a range of 17-21°C according to the individual wishes of the members of expedition. It have to be stressed that a temperature varies with the distance from a floor. Figure 1 illustrates the records of the termographes placed in the rooms at 10 cm and 120 cm distance above a floor. During summer the differences in temperature between these two levels sometimes reach 7-8°C.

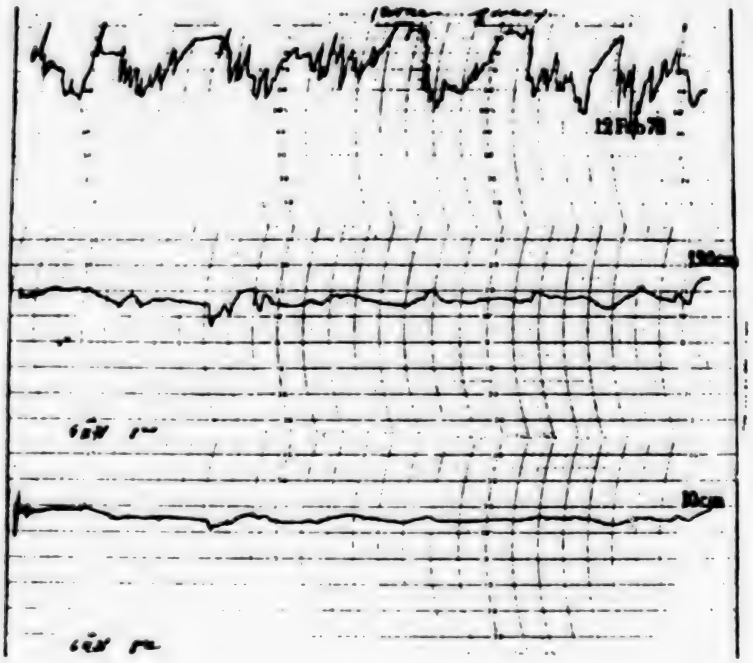

Fig. 1. Records of thermographs placed in the rooms at 10 cm and 120 cm distance above floor

Because of it we considerd as an important matter the determination of a course of acclimatisation to cold among the winterers in our station. The thermoregulation system and the endocrine system have been tested. The following methods were used:

- the questionnaire related to the thermic comfort inside and outside PAS,
- the questionnaire and thermometric examination for evaluation of the dresses used by the members of our expedition,

- Budd's test performed before, in the middle, and after a winter season.

Some results of these studies are given in table 3 and fig. 2.

Table 3. Clothing of personnel in different climatic conditions (2nd Polish Antarctic Expedition 1977/1978)

Group of personnel	Clothing insulation (clo)	Air temperature (°C)	Wind velocity (m/s)	Wind chill index Units after simple and passel
scientific personnel	1.5-1.7	2.0(1-3)	7-10	950
technical personnel	1.7-2.0	2.0(1-3)	7-10	950
scientific personnel	2.3-2.5	-3°C	10	1250
	2.3-2.5	0°C	20	1620
technical personnel	2.4-2.7	0°C		1620

In these time periods (before, in the middle, and after winter), the blood concentration of a thyroid hormone (T_3), cortisol and insulin was determined.

Next important question is the effect of polar conditions on the metabolism of water and minerals. Water used for drinking in the polar stations is poor in minerals and deficient in many minerals and microelements. For example, after 3 months of staying during summer we have observed the fall of blood concentration of potassium and calcium in vast majority of the members of our expedition. Increasing the ammount of minerals, microelements and vitamins in a diet probably diminishes these effects. We expect to learn more about the disturbances of the mineral metabolism when the investigations of the inorganic component of bone will be completed. It is done by radiographic determination of the bone compactness of the phalanx of winterers. The examination is done twice: before and after the winter season.

In addition we investigate the energy balance and the course of sleeping with the aid of questionnaire methods. The research will benefit from the fact that physicians stay in the station during winter.

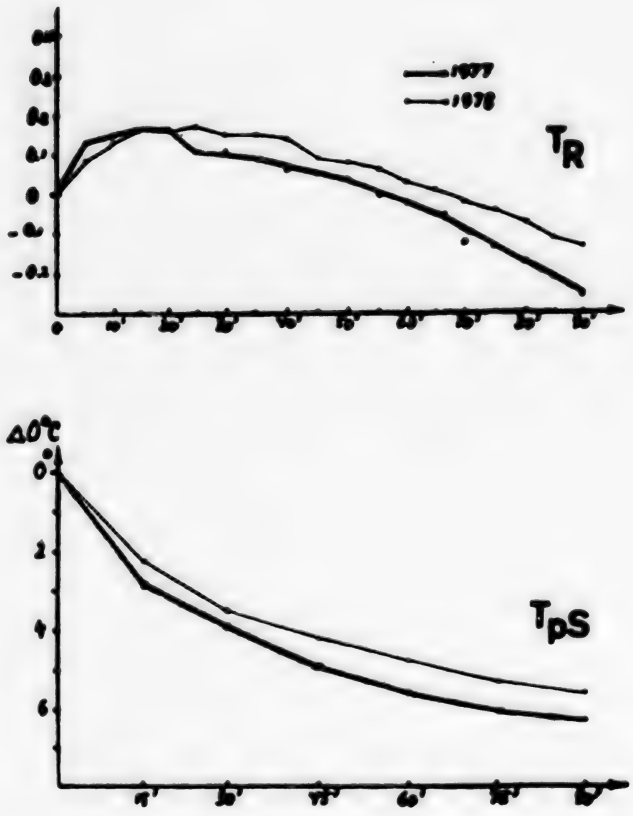

Fig. 2. Records of temperature of winterers: T_R - rectal temperature, T_S - skin temperature, 1977 and 1978 winterers

Studies of biorhythms

The internal synchrony of the circadian physiological rhythms is a condition of health. There is a mutual dependence between many circadian rhythms, and their various desynchronizations result in disturbances of function of the central nervous system, the endocrine system and the digestive system.

The internal synchrony of the biorhythm is mantained due to the presence of synchronizers, so called "time-donors" (Zeitgeber). There are primary and secondary (or dominant and dependent) synchronizers. For

most of land animals, and for part of water animals too, the primary synchronizer is light, or more specifically the day-night cycle. In animals and in men there occure "free running" rythms (with other than 24 hours cycle period) in conditions of isolation with the lack of time meters, with constant light or constant darkness.

A man is under control of the other synchronizer - a social one. The social synchronizer and light are two dominant synchronizers for a man. Other synchronizers of the circadian rhythms are geophysical factors: gravitational field, electric field, magnetik field, UV radiation, and others.

Staying in a polar area offers an unique opportunity to study the effects of the photoecological and geophysical factors, and later discussed problem of psychosocial isolation, on the circadian activity of a man.

The methods used for evaluation of circadian rhythms in the winterers of PAS are presented in table 4.

Table 4. Methods for evaluation of circadian rythms in the winterers of P.A.S.

Circadian rhythms	pH
Vital signs	K^{o}, Na^{o}, Ca^{oo}, Cl'
oral temperature	Seasonal rhythm
pulse	Physical fitness
blood pressure	Anthropometry
ventilation	
Physical fitness - performance	
PWC_{170}	
hands strength	
eye hand coordination	
random addition	
time estimation	
reaction time	
Urine	
volume	

Chronobiologic studies are supplemented with a selective determination of antropometric parameters and of physical efficiency in a seasonal rhythm.

The results of the First Antarctic Expedition of Polish Academy of Sciences indicate the change of characteristics of the rhythm of the psychophysical efficiency of a man, related to the length of time of staying in the polar area. The dynamics of these changes depend on the vegetative type of the person under consideration.

Isolation of small groups of persons in the conditions of antarctic winter

Systematic studies of the adaptation of small task groups to conditions of a social isolation in Antarctic Continent were initiated by american psychiatrists and psychologists during the International Geophysical Year 1957/1958. The detailed review of literature on this problem was elaborated in George Washington University Medical Center (1974). This review indicates that the adaptation to isolation is a very complicated matter and that it needs further investigation with the new techniques, taking into account the cultural differences as well as the size and the structure of the group.

Considering the above mentioned arguments, in Polish Antarctic Station the research on two basic psychological problems have been realized since 1976:

- the dynamics of man' adaptation to winter,
- the polarization of the small task groups.

The empiric data related to so called "social isolation effects" are accumulated under the three basic entries: confinement, isolation, sensory deprivation. The scope of the above mentioned words is not sharply defined and it causes a number of controversial results (see Burns et al., 1963).

Polish psychologic research uses the following operational definition of isolation: an isolation is not only a spearation from the environment to

which a man was previously adapted but it is also connected with the restriction of the liberty of action (elements of confinement in a sense of encapsulation) and with the separation from the normal stimuli from environment (an elemnt of a sensoric deprivation). We are of an opinion that such a definition is very useful for the extrapolation of the results of our research to the problems of space medicine and psychology.

The studies of the psychological aspects of the adaptation to the extremal conditions of the antarctic environment are essential for the effective work of the expedition as well as for the elucidation of the specific mechanisms of behaviour during a period of a social isolation. Psychologic studies done in Antarctic up to now agree that the winterers adapted to a social isolation have to pay "psychological costs" called "the winterers symptoms". The symptoms are: nostalgia, disorders of sleeping, psychosomatic disorders, irritability, agressiveness, etc. Figures 3, 4 and 5, taken from the work of E.K.E. Gunderson and P.D. Nelson (1963) illustrate the dynamics of the winterers symptoms. For example, disorders of sleeping and depressive states prevail in the middle of winter, while irritability reach the maximum at the end of winter. Our observations concerning the winterers in Arctowski memorial Polish Antarctic Station confirm these trends but we have observed quite large individual differences resulting in a considerable spread of results.

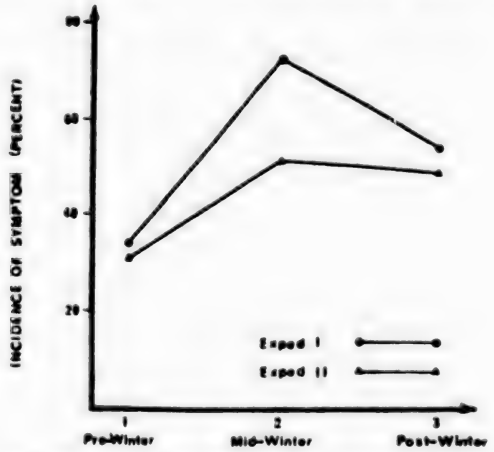

Fig. 3. Reported incidence of "difficulty in falling asleep or staying asleep" for Antarctic groups in three time periods

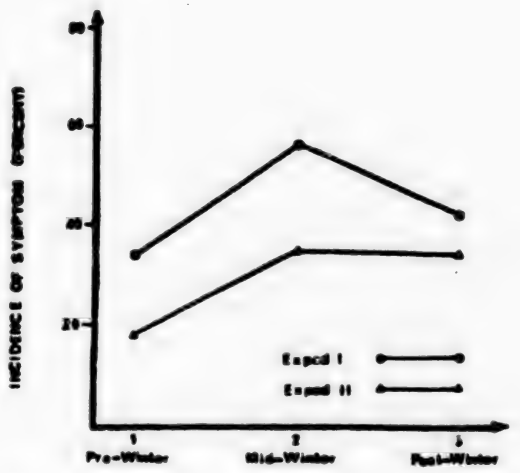

Fig. 4. Reported incidence of "feeling blue" in Antarctic groups at three time periods

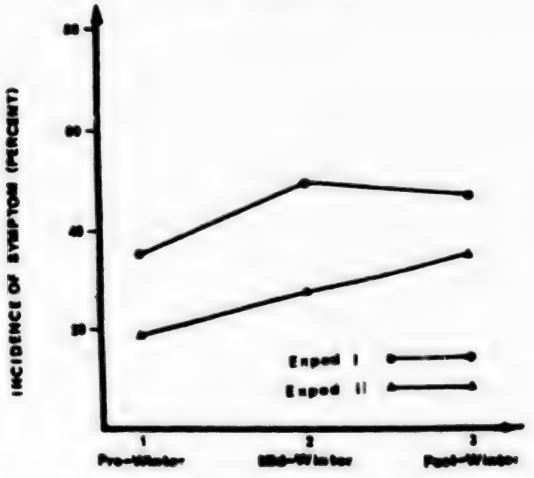

Fig. 5. Reported incidence of "easily annoyed or irritated" for Antarctic groups at three time periods

According to several reports (e.g. Palmai, 1963) there are no essential disturbances of personality in conditions of an antarctic isolation. This conclusion is confirmed by our studies performed in PAS in 1977/1978 with the use of "The questionnaire for testing of temperament" by J. Strelau[x], "Inventory of personality" by H.J. Eysenck, "A psychological self-

[x] See: J. Strelau "Temperament i typ układu nerwowego", Warszawa 1969, PWN.

portrait" by Stein[xx] and "The scale of autotesting" by Spielberger. The detailed data concerning the personality and psychical needs of polish winterers are presented in tables 5 and 6.

Table 5. Analysis of variance scores stein's "self-description test" for Polish Antarctic Parties in 6 consecutive measurements during 12-month period of isolation at H. Arctowski station 1976/1977

Number of need	F	p	Number of need	F	p
1	0,66	n.s.	14	1,50	n.s.
2	0,58	n.s.	15	0,60	n.s.
3	0,50	n.s.	16	0,40	n.s.
4	0,21	n.s.	17	1,76	n.s.
5	0,69	n.s.	18	1,10	n.s.
6	0,30	n.s.	19 isolation	2,10	0,05
7	1,40	n.s.	20	0,30	n.s.
8	0,28	n.s.	21	0,80	n.s.
9	0,09	n.s.	22	0,50	n.s.
10	0,14	n.s.	23	0,40	n.s.
11	0,27	n.s.	24	0,20	n.s.
12	0,46	n.s.	25	1,40	n.s.
13	0,30	n.s.	26	0,40	n.s.

N = 18; df = 5/108

As indicated by the analysis of variance there is no statistically significant differences between six consecutive examinations (with the exception of the need for isolation which diminished near the end of winter).

In spite of the lack of the objective evidence for the personality disorders, many of the winterers have stated that they better accepted the

[xx] Exsenck's and Stein's questionnaires are the polish adaptation done in the former Psychometric Laboratory of Polish Academy of Sciences.

fact that there is nothing for it but to stay in Anctartic than the fact of the adaptation to a social isolation.

Table 6. Analysis of variance scores for Polish Antarctic Parties in 6 consecutive measurements during 12-month period of isolation at H. Arctowski station 1976/1977

Questionnaires	Traits	F	p
Eysenck	neuroticism	1,02	n.s.
	extraversion	0,54	n.s.
	simulation	0,47	n.s.
Strelau	strength of excitatory process	0,60	n.s.
	strength of inhibitory process	0,70	n.s.
	mobility of nervous process	1,02	n.s.
Spielberger and all.	anxiety (as state)	0,14	n.s.
	anxiety (as trait)	1,17	n.s.

N = 18; df = 5/108

According to several publications (C.S. Mullin, 1960) the winterers easier adapt to the physical environment of Antartic, the monotony ot the surroundings and the lack of normal sources of gratification than to life in the isolated groups of persons (A.J.W. Taylor, 1973; S.B. Sells and E.K.E. Genderson, 1972; R.E. Strange and W.J. Klein 1973, and others). Therefore, the research going in the Arctowski memorial PAS on polarization of small task groups, their formal and unformal structure, the role of a leader, the stages of polarization, the direction and intensity of social interaction etc. are justifiable from the point of view of space psychology. The detailed results of whis work will be published separately.

Elaboration of the health criteria for the recruitment of candidates for polar expeditions

All candidates for polar expeditions are subjected to medical examinations in the Military Institute of Aviation Medicine, Warsaw. This includes the examinations by physicians of several specialities, functional tests and laboratory tests. The candidates are subjected to the following examinations: internal, surgical, laryngological, oculistic, psychiatric, neurologic, stomatologic, psychologic, antropologic (winterers only), radiologic and others if ordered by any of the physicians, ECG examination in rest and after work, test on a Barany chair, statmokinesimetric examination (in persons working on heights), in some cases also EEG examination and laboratory testing of blood and urine.

The illustration of the health status of the members of the expedition is the table with the reasons for medical consultations given by medical staff during the Second Antarctic Expedition of Polish Academy of Sciences 1977/1978 and the table of cases of diseases of the winterers of the First Antarctic Expedition of Polish Academy of Sciences.

In conculsion one have to state that in the antarctic scientific laboratories, including those of Arctowski memorial Polish Antarctic Station, it is possible to obtain more informations pertinent to space medicine and space psychology than in laboratories of a different type. Participation of the first Pole in space flight of the "Interkosmos" programme fully justifies the realization of the medical and psychological research programme in Antarctic.

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